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# Review

*Kant: Natural Science*

Eric Watkins (ed.)

The Cambridge Edition of the Works of Immanuel Kant

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Recent years have witnessed a great spurt of research activity on Kant's natural science. Kant scholars have long appreciated the central role that Kant's reflections on natural science play in the overall economy of Kant's theoretical and also practical philosophy.<sup>1</sup> What is distinctively new in this recent trend is the attention paid to the historico-philosophical context behind Kant's natural science, and the very nuanced influences that both Newton's natural philosophy and Leibniz's dynamics exercised on him.

The present edited collection of Kant's essays on natural science by Eric Watkins is a marvelous addition to The Cambridge Edition of the Works of Immanuel Kant. It comprises of sixteen essays, and brings to the English-speaking world the very first English translation of Kant's *Thoughts on the True Estimation of Living Forces* (1746–9) as well as of translations of many other less well-known essays about the age of the Earth (1754), the causes of earthquakes (1756), the theory of winds (1756), and the volcanoes on the Moon (1785), among others. The volume offers also new English translations, with extensive notes and very informative introductions, of classical texts such as *Universal Natural History and Theory of the Heavens* (1755), and *Physical Geography* (1802), among others, spanning across both Kant's pre-Critical and Critical period. What clearly emerges from this edited collection is Kant's systematic engagement with a surprising variety of scientific topics throughout his career. In what follows, I concentrate my attention very selectively to three pre-Critical texts – *True Estimation*, *Universal Natural History*, and *On Fire* – to highlight one particular theme emerging from Kant's natural science and its lasting impact on Kant's mature work: namely, Kant's reflection on the nature of the repulsive force.

*True estimation* was Kant's very first text back in the late 1740s. Despite Kant's own demise of this work in later years, *True estimation* is a very important text to understand the cultural background against

<sup>1</sup> See E. Adickes (1924) *Kant als Naturforscher*. Berlin: de Gruyter.

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which the young Kant developed his seminal ideas on forces and dynamics. The topic is the then lively debate between Cartesians and Leibnizians on the nature of forces at work in elastic collisions, in particular the debate between Descartes's so-called *dead force* ( $mv$ ) and Leibniz's *living force* ( $mv^2$ ). The ambitious goal of the twenty-one-year-old Kant was to criticize at length Leibniz and to offer his own resolution of the debate. Kant's solution consisted in supplementing the Cartesian account, which he thought was mathematically correct, with a metaphysical analysis of how Cartesian dead forces can ultimately become Leibnizian living forces via a process that Kant calls "vivification".

That Kant's final outcome is unsatisfactory and scientifically dubious does not really matter for the purpose of assessing the relevance and lasting impact of Kant's seminal ideas here. In particular, one of those ideas concerns the elastic force or elasticity, which – quoting the Cartesian Jean Jacques Dortus de Mairan, in his dispute with the Leibnizian Marquise du Châtelet – Kant describes as "the true machine of nature" (1: 55.9–34). Kant believed that elastic impacts among bodies had the power to unleash some primordial elastic force as an *inner Naturkraft*, whose physical cause or seat had yet to be found. Leibniz had himself defended elasticity as a fundamental property of bodies, unleashed by elastic collisions, in the *Specimen Dynamicum*. But the young Kant wanted to take the distance from Leibniz by embarking on a journey about the metaphysical foundations of dynamics, a journey that led him ultimately to the identification of the air first (and the ether next) as the physical cause of elasticity. In so doing, the young Kant was latching onto another dominant trend of his time, namely the speculative Newtonian experimentalism of the *Opticks*.

Newton has speculated about air, first, and ether next, as the physical seat of a fundamental repulsive force since his pre-*Principia* text, *De Aere et Aethere* as well as his famous letter to Boyle on 28 February 1678/9.<sup>2</sup> In the Queries added to the Latin edition (1706) and second English edition (1717) of the *Opticks*, Newton returned to the theme of the ether as a medium for attractive and repulsive forces and ultimately responsible for a variety of optical, thermal, electric phenomena, as well as chemical reactions. Newton's speculations about the air and the ether had a profound influence in the natural philosophy of the time. In England, Stephen Hales's *Vegetable Staticks* (1727)

<sup>2</sup> I. Newton (1674). "De aere et aethere". In A. R. Hall, M. B. Hall (Eds.), (1962) Unpublished scientific papers of Isaac Newton (pp. 214–228). New York: Cambridge University Press.

elaborated on the theme of “elastick air” as the seat of a fundamental repulsive force at work in fermentations and distillations. In the Netherland, Hermann Boerhaave’s *Elementa Chemiae* (1732) defended the ether as a subtle material fluid, identifiable with the matter of fire, and at work in combustion phenomena and transitions of physical states.

It is no surprise then that seven years after *True estimation of Living Forces*, Kant returned to the theme of an *inner Naturkraft* – this time filtered through the lenses of this Newtonian tradition – and in *Universal Natural History*, he laid down the Newtonian principles for a cosmogony. Kant imagined the universe at the beginning as filled with a “fine matter”, on which the fundamental forces of attraction and repulsion acted. The former by lumping the fine matter; the latter by counterbalancing attraction and making matter whirl into vortices of different densities, which eventually resulted in stars and planets. Kant borrowed abundantly from the Newtonian tradition and references to Hales and Boerhaave are explicit in Kant’s treatment of the “elasticity of the atmosphere of the Sun”, where he speculated that substances such as saltpetre – producing elastic air in the bowels of the Sun – could ultimately explain the Sun’s internal fire.<sup>3</sup>

The same themes re-appear in *On Fire*, dating also back to 1755. This time Kant resorted to an ethereal elastic matter as the medium of light and fire, intermixed in all bodies, counterbalancing the attractive force, and responsible for transitions of physical states. Kant’s elastic matter was nothing but an idiosyncratic blend of Newton’s optical ether and Boerhaave’s material fire, and a year later in the 1756 *Theory of Winds*, the elasticity of the air (with its decrease of expansive force by cold and vapour) was singled out as the cause of winds. It comes as no surprise then that in *The Only Possible Argument* (1763), Kant referred to gravity and elasticity as two *grounds* for a plurality of effects such as “the laws of respiration” but also “of necessity the ground of the possibility of pumps, of the generation of clouds, of the maintenance of fire, of the winds, and so on” for elasticity (2: 106); and the spherical shape of the earth and the Moon’s orbit, among others, for gravity. In virtue of these two fundamental principles of nature, Kant articulated a view of the lawful unity of nature and necessity of the laws of nature, which was bound to have profound influence for his mature view in the

<sup>3</sup> For details, please see M. Massimi (2011) “Kant’s dynamical theory of matter in 1755, and its debt to speculative Newtonian experimentalism”, *Studies in History and Philosophy of Science* **42**, 525–543.

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Critical period, especially in the *Metaphysical Foundations of Natural Science* (1786), where attraction and repulsion became the two fundamental forces through which matter fills a space and communication of motion can be ultimately explained.

Obviously, there is much more to Kant's natural science than just his treatment of dynamic forces such as attraction and repulsion, as my brief remarks above may suggest. Kant's views of space, relative and absolute motion is another central feature of his reflections on natural science, spanning from the qualified relationism of *Physical Monadology* and *New Doctrine of Motion and Rest* (1758) – both translated in the present volume – to the transcendental analysis that begins to emerge with the *Inaugural Dissertation* (1770). Without mentioning Kant's *Physical Geography*, a topic that occupied Kant's lecture courses for a total of forty-nine times during his life, and which also features prominently in the present edition.

To conclude, Watkins' volume on Kant's *Natural Science* is a long-awaited and splendid addition to The Cambridge Edition of the Works of Immanuel Kant. Not only is it a most welcome and timely contribution to the blossoming field of scholarship surrounding Kant's natural science. But it also delivers a complete, definitive, and sophisticated picture of Kant's life-long engagement with the natural sciences – broadly construed –, an engagement that invites more reflections and opens up new avenues in underexplored territories. This volume – masterly edited with introductions, detailed footnotes, and a glossary of terms – is a milestone in Kantian scholarship. It sets the research agenda for the next generations of Kantian scholars that will want to engage with the fascinating field of the history and philosophy of the eighteenth-century natural sciences.

**Michela Massimi Q1**